1. INTRODUCTION

1.1 Terms of Reference

Lehigh Cement Company (Lehigh) submitted the first draft of this Feasibility Study Technical Report (dFSTR) to the Washington Department of Ecology (Ecology) in November 2003. Ecology reviewed the dFSTR and transmitted their comments on the dFSTR to Lehigh in a letter dated 13 July 2004. This document is the first revision of the dFSTR (Revised dFSTR). This Revised dFSTR addresses Ecology's comments on the first dFSTR and includes information and analyses that were compiled by Lehigh and Ecology subsequent to submittal of the first dFSTR.

This Revised dFSTR examines remedial alternatives for groundwater and groundwater-related impacts at the Lehigh Closed Cement Kiln Dust (CKD) Pile Site in Metaline Falls, Washington (the Site). The Site is owned by Lehigh. GeoSyntec Consultants (GeoSyntec) prepared this Revised dFSTR for submittal to Ecology on behalf of Lehigh. This dFSTR is one of a series of deliverables specified in Agreed Order No. DE99HS-E941 (1999 AO)[1].

1.2 Organization of the Feasibility Study Technical Report

The remainder of this Revised dFSTR is organized into the following sections:

- Section 2, *Background*, summarizes information from the Remedial Investigation (RI) and additional data gathered subsequent to preparation of the RI that is relevant to this Revised dFSTR.
- Section 3, *Regulatory Framework for Additional Remedy Alternative Selection*, describes relevant Washington Administrative Code (WAC) and 1999 AO requirements.

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[1] Exhibit 1.1-1, Agreed Order Compliance Checklist, notes the status of the deliverables required by the 1999 AO.

- Section 4, *Description of Alternative Groundwater Remedies,* describes the final six alternative groundwater remedies evaluated in this Revised dFSTR.

- Section 5, *Alternative Comparison,* uses the criteria described in WAC 173-340-360 and the 1999 AO to compare the six alternative groundwater remedies.

- Section 6, *Conclusions*, presents the conclusions of this 1999 AO deliverable.

References, exhibits, and appendices are included at the end of the document.

2. BACKGROUND

2.1 General

This section summarizes the background information contained in the Final RI Report [GeoSyntec, 2001], the Feasibility Study Technical Memorandum [GeoSyntec, 2003b], and the Supplement to the Draft Feasibility Study Report (Supplement) [GeoSyntec, 2004]. The information in Appendices A and B to this Revised dFSTR was obtained after the RI and FSTM were submitted. These appendices contain data relevant to the comparison of alternatives. Appendix A was originally submitted with the first draft of the dFSTR to describe pilot in situ carbon dioxide groundwater treatment system (Pilot System) performance as well as the additional investigation of areas downgradient of the Closed CKD Pile that occurred in Summer 2003. Appendix A now also includes an update section that documents data and events from November 2003 through February 2005. Appendix B contains Ecology's report on their Summer 2004 investigation. Appendix C contains boring logs and geologic cross-sections developed from Lehigh's Site investigation data.

2.2 Site Location and Layout

The Closed CKD Pile is in Metaline Falls, Washington, a town of approximately 200 people, approximately 100 miles north of Spokane and 13 miles south of the Canadian border (Exhibit 2.2-1). Seasonal temperature variation is significant, with monthly average temperature extremes ranging from below 10°F to above 90°F [GeoSyntec, 2001]. The Site mean annual precipitation is 28 in. [GeoSyntec, 2001].

The Closed CKD Pile lies on approximately 7 acres west of State Route 31. It rises approximately 90 ft above State Route 31 at 2H:1V (Horizontal to Vertical) to a gently sloping upper deck with a maximum elevation of approximately 2,132 feet mean sea level (ft MSL). To the east of State Route 31 is a floodplain that gently slopes toward Sullivan Creek about 250 to 300 ft east of the highway. The average elevation of the floodplain is 2,026 ft MSL.

Lehigh owns the land north and hydraulically downgradient of the Closed CKD Pile and has made several improvements since the Site environmental work began (Exhibit 2.2-1).

2.3 Site Environmental Data

2.3.1 Surface Water

Sullivan Creek drains a watershed of approximately 90,880 ac [EIP, 1999]. The maximum mean flow in the creek is approximately 650 cubic feet per second (cfs); the minimum mean flow is approximately 100 cfs. Maximum flows in the creek occur during the months of May and June; minimum flows occur during August and September. Fluctuations in creek flows are a result of seasonal rainfall and snowmelt, as well as releases from the Sullivan Lake Dam to Sullivan Creek upstream of the Site [USGS, 1999]. The dam controls the volume of water that flows into Sullivan Creek. Since 1954, the highest recorded water level increase in the Sullivan Creek USGS gauging station[2] upstream from the Site is 6.20 ft. Sullivan Creek adjacent to the Site is wider than where the gauging station is located. Thus, water level fluctuations adjacent to the Site are lesser than those measured at the gauging station. The average increase during peak flow periods (May and June) is approximately 4 ft. Sullivan Creek flows northwest past the Site to join the Pend Oreille River, less than a mile downstream of the Site.

2.3.2 Site Geology

Two geologic strata at the Site are relevant to this Revised dFSTR (Exhibit 2.3-1):

- Glacial Sediments. Overlying the bedrock[3] are glacial sediments composed of glaciofluvial (river terrace) and glaciolacustrine (glacial lake) sediments that consist of sandy silt and clayey silt. The glacial

[2] USGS Sullivan Creek station at Metaline Falls, Station 12398000.
[3] See the RI for data about the bedrock, which is not considered relevant to this Revised dFSTR.

sediments are subject to landsliding. Immediately to the south of the Closed CKD Pile is an historic landslide [Dames and Moore, 1997] that is considered during the evaluation of alternatives. The historic landslide consists of disturbed sediments to an unknown depth along unknown slip planes. This area above the landslide rises in steep relief progressing south from the Closed CKD Pile.

- Holocene Alluvium. Sullivan Creek eroded a bowl into the glacial sediments. The creek deposited gravels with occasional cobbles and boulders and interspersed zones of more clayey, silty and sandy materials into the base of the bowl and on the floodplain. This layer is generally about 20 ft thick and overlays the glacial sediments.

CKD was placed in part over each of these geologic strata. In the southern and central portion of the now closed pile, boring logs from abandoned Monitoring Wells MW-11 and MW-3 indicate that CKD was placed in ravines incised into the glacial sediments [Dames and Moore, 1992, 1993]. In the central and northern portions of the pile area, CKD was placed directly over the Holocene alluvium. Appendix C contains boring logs and cross-sections of the Site.

2.3.3 Site Hydrogeology

The sources of groundwater at the Site are as follows (Exhibits 2.3-1 and 2.3-2):

- Precipitation. Rainfall and upgradient runoff infiltrates the glacial sediments, the landslide debris, and the Holocene alluvium to become groundwater.

- Glacial Sediments. Infiltrating precipitation generally seeps down and horizontally to the north and east through the Site area glacial sediments. Groundwater emerges from the glacial sediments as surface seeps along the sloping hillsides that form the bowl into which the CKD was placed. Groundwater migrates along sporadic lenses in the glacial sediments, and varies in amounts and locations according to season and precipitation intensity. Seepage from the landslide debris seeps into and beneath the Closed CKD Pile and then into the Holocene alluvium (i.e., sands and gravels) beneath the pile.

- Holocene Alluvium. Seepage from the glacial sediments and portions of the Closed CKD Pile affected by this seepage enters the Holocene alluvium beneath the pile. This groundwater then moves horizontally in a general northern and eastern direction, beneath State Route 31 and hence to Sullivan Creek. The depth to groundwater in the Holocene alluvium is approximately 2 to 3 ft below ground surface within the floodplain. The depth to groundwater increases to approximately 5 to 6 feet below ground surface near the toe of the Closed CKD Pile, where the ground surface is higher in elevation than the floodplain.

Lehigh and Ecology disagree regarding the degree of seepage into the sides of the Closed CKD Pile. The Supplement summarizes Lehigh's concept [GeoSyntec, 2004]. Appendix B of the Revised dFSTR contains information on Ecology's position on the relative amounts of seep flow and underlying alluvial floodplain groundwater flow. Nevertheless, this disagreement does not affect the feasibility study for the Site or the content of this Revised dFSTR. The relative amount of seep flow and underlying alluvial floodplain groundwater flow into the Closed CKD Pile is not discussed in this report.

2.3.4 CKD Effects on Groundwater

Ecology has overseen several environmental investigations at the Site since 1991. Lehigh collected samples from CKD, groundwater, surface water, seeps, soil, and sediment media. The Site sampling points are shown on Exhibit 2.3-3. The following is a summary of the effects of the Closed CKD Pile on the Site groundwater: [4]

- The Site groundwater table elevation under the Closed CKD Pile fluctuates seasonally and annually depending on precipitation and runoff conditions. During initial site investigations groundwater wells were installed into and through the regraded and compacted CKD pile. These groundwater wells were abandoned in preparation for final cover installation in 1996. Groundwater level data from those wells indicate that these fluctuations under the Closed CKD Pile typically do not exceed more than approximately one foot from the mean alluvial floodplain groundwater elevation.

- Groundwater inundates portions of the base of the Closed CKD Pile. The amount of inundated CKD increases when the groundwater level rises and decreases when groundwater level falls.

- The pH of groundwater that contacts the CKD increases as a result of the contact. The affected water subsequently moves into the groundwater, increasing its pH.

- Two other mechanisms are also contributing to groundwater effects from CKD. Water flows laterally into the buried sidewalls of the Closed CKD Pile, especially in the historic landslide area. Water is also trapped in the CKD matrix from infiltration prior to pile closure. This water drains from the CKD until moisture equilibrium within the CKD matrix is attained. The water eventually joins the underlying groundwater before it migrates north-northeasterly toward Sullivan Creek.

- The high pH groundwater causes naturally occurring arsenic in the Site soils to go into solution in the groundwater. Arsenic is not present in significant concentrations within the CKD.

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[4] See the RI Report submitted to Ecology in 2001 [GeoSyntec, 2001] and the Interim Progress Report on Subsurface Treatability Study submitted to Ecology in 2000 [GeoSyntec, 2000].

- Downgradient groundwater is characterized by high pH[5], decreased oxidation reduction potential[6], and arsenic concentrations greater than 5 μg/L (or parts per billion (ppb)) (Exhibit 2.3-4).

- Groundwater with elevated pH and arsenic levels seeps into and flows overland (in a localized area) into Sullivan Creek.

2.4 Site Regulatory History

The following summary describes the major regulatory actions at the Site since 1984, when CKD became subject to regulation under the state Dangerous Waste regulations:

- Prior to 1984, both the federal government and the State of Washington exempted CKD from regulation as a hazardous or dangerous waste. In 1984, the State of Washington withdrew its exemption and CKD became subject to regulation as a dangerous waste under the Hazardous Waste Management Act (Chapter 70.105 of the Revised Code of Washington (RCW)) and its implementing Regulations (Chapter 173-303 WAC). CKD is still exempt from the federal hazardous waste regulations (40 CFR 261.4(b)(8)).

- 1984 – Lehigh submitted a "Notification of Dangerous Waste Activities" form and Part A of its Dangerous Waste Permit Application to notify Ecology that CKD would be managed at the Metaline Falls facility. Upon submittal of the Part A application, the Lehigh cement plant became an interim status dangerous waste treatment, storage, and disposal (TSD) facility.

- 1984-1992 – Lehigh investigated options for the CKD. Lehigh evaluated the feasibility of CKD beneficial reuse or recycling,

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[5] In excess of the State water quality standard of 8.5 and, in some locations, higher than the State dangerous waste threshold of 12.5.

[6] Redox potential or Eh.

preliminarily assessed the Site characterization options, and compiled descriptions of potential closure options. Dames and Moore used the information as a basis for and to supplement their subsequent evaluations [Bovay, 1991 and 1992; Cemtech, 1991].

- 1992-93 – Lehigh conducted an investigation to characterize the CKD Pile and to evaluate the quality of groundwater beneath and adjacent to it, the results of which are described in Section 2.3.

- 1994-95 – Lehigh continued to explore closure options for the CKD pile. In a 1994 letter to Lehigh, Ecology concluded that the CKD Pile should be closed in place [Ecology, 1994].

- 1996 – Lehigh submitted its "Final Closure Plan Cement Kiln Dust Pile, Metaline Falls, Washington" (7 June 1996). Ecology approved the Closure Plan by letter dated 13 June 1996.

- 1996 – Lehigh implemented the approved closure plan by constructing a final cover on the surface of the CKD Pile to reduce surface water infiltration and by constructing a stormwater management system to convey surface water run-on and run-off.

- 1996 – Ecology issued Administrative Order No. DE96HS-E934 (1996 AO), requiring Lehigh to submit and implement a short-term post-closure care plan. The 1996 AO required two years of groundwater monitoring.

- 1997 – Lehigh submitted to Ecology a "Short-Term Postclosure Care Plan, Cement Kiln Dust (CKD) Pile, Metaline Falls, Washington," which documented Lehigh's plans for groundwater monitoring and maintenance of the final cover and stormwater management system during the "short-term" post-closure period.

- 1997 – Lehigh provided closure certification, including documentation of the construction of the final cover and stormwater management system, in the "Closure Report for Cement Kiln Dust (CKD) Pile, Metaline Falls, Washington," dated 17 June 1997. Post-closure care of the Site was required, because dangerous waste (CKD) remained on the Site after closure.

- 1997-98 – In accordance with the 1996 AO, Lehigh collected groundwater monitoring data on a monthly basis. Lehigh also inspected, maintained, and made routine repairs to the final cover and stormwater management system during this time period.

- 1998 – Lehigh conducted an emergency remedial action under Enforcement Order No. DE98-HS-E938 (1998 EO), consisting of grading and filling a low-lying portion of the Site then owned by the Washington Department of Transportation (WDOT). This interim action, referred to as the "WDOT Deck Extension," reduced the potential for direct contact with high pH groundwater surfacing in the area.

- 1999 – Lehigh submitted to Ecology the "Post-Closure Care Groundwater Monitoring Data Review, Closed Cement Kiln Dust Pile, Metaline Falls, Washington," a report summarizing post-closure groundwater monitoring data collected between December 1996 and December 1998. These data indicated that leachate was emanating from the Closed CKD Pile during the post-closure monitoring period, affecting groundwater beneath and downgradient of the Site as described in greater detail in Section 2.3.

Up to this point, Ecology had regulated the Closed CKD Pile as a TSD under Ch. 70.105 RCW. The monitoring data collected between 1996 and 1998 demonstrated that releases of hazardous substances were occurring at and downgradient of the Closed CKD Pile. Based on these data, Ecology and Lehigh began assessing potential remedial action at the Site.

- 1999 – Ecology and Lehigh signed an Agreed Order (No. DE99HS-E941) (1999 AO) under the Model Toxics Control Act (MTCA) in October 1999. Under the 1999 AO, Lehigh agreed (a) to perform a remedial investigation and feasibility study (RI/FS); and (b) upon approval of the RI/FS, to prepare a preliminary draft Cleanup Action Plan (pdCAP).

- 2001 – Lehigh submitted a Draft Final Remedial Investigation Report (Draft RI). The Draft RI compiled existing information and new environmental data collected over the previous two years. Lehigh prepared the Draft RI consistent with WAC 173-340-350(7).

- 2001 – Lehigh began conducting a feasibility study (FS). To evaluate potential cleanup technologies, Lehigh proposed and Ecology accepted bench scale tests for various treatment technologies. Carbon dioxide diffusion bench scale tests produced promising results.

- 2002 – Ecology shifted the Site from the Dangerous Waste Program to the Toxics Cleanup Program.

- 2002 – Lehigh installed the Pilot System to evaluate this innovative in situ carbon dioxide diffusion groundwater treatment technology.

- 2003 – As required by the 1999 AO, Lehigh submitted a Feasibility Study Technical Memorandum (FSTM) containing a preliminary screening of potential remedial technologies. Lehigh prepared the FSTM consistent with WAC 173-340-350(8)(b).

- 2003 – As required by the 1999 AO, Lehigh submitted the first dFSTR to Ecology. The first dFSTR evaluated the remaining alternatives that resulted from the screening documented in the FSTM and alternatives requested by Ecology.

- 2004 – Lehigh conducted further analyses of the Site's groundwater flow regime and how CKD affects groundwater at the Site. Lehigh submitted the Supplement to the Draft Feasibility Study Report to Ecology to share the results of the analyses.

- 2004 – Ecology conducted a Summer work program to collect additional site data.

2.5 Previous Site Remedial Actions

2.5.1 General

This section describes remedial actions that Lehigh previously implemented at the Site. The capital and operation and maintenance cost for these measures exceeds $13 million (US $2005) over the years 1995 - 2004. Lehigh continues to operate and maintain these remedial measures in compliance with applicable regulations.

2.5.2 Source Control

In accordance with State Dangerous Waste Regulations, Lehigh closed the CKD Pile in 1995 – 1996 [D&M, 1997]. Closure involved reconfiguring and consolidating CKD deposits, installing an engineered final cover system, controlling surface water, and implementing institutional controls (See Exhibit 2.2-1). The Ecology-approved closure eliminated the primary adverse physical and chemical effects of the Site and eliminated direct contact with CKD as a human health and environmental risk. In addition, precipitation and surface run-on to the pile no longer contacts the CKD, decreasing water percolation through the pile and eliminating a mechanism for CKD to affect groundwater.

2.5.3 Downgradient Controls - Deck Extension

High pH groundwater daylighted in a low-lying area downgradient of the CKD Pile and adjacent to WDOT's working gravel deck. In 1998, Lehigh and Ecology recognized that this area posed an exposure risk and jointly developed a solution. Lehigh filled the low-lying area (Exhibit 2.2-1) 9 through 14 November 1998 consistent with the 1998 EO [GeoSyntec, 1998].

2.5.4 Pilot Test - In Situ Groundwater Treatment Wall

Lehigh installed a Pilot System in October through November 2002 (Exhibit 2.2-1). Previous reports submitted to Ecology include detailed descriptions of this treatment technology and the Pilot System [GeoSyntec, 2000, 2001, 2002, 2002, 2003a, and 2003b]. Appendix A includes an evaluation of the pilot treatment system performance.

2.5.5 Performance Evaluation

Pursuant to the 1996 AO and 1999 AO, Lehigh has performed surface water, groundwater, and systems monitoring, including:

- short-term post-closure monitoring (groundwater, surface water, and closure systems) on a monthly basis;
- long-term post-closure monitoring (groundwater, closure systems) on a quarterly basis with weekly visits to the Site;
- performance monitoring (groundwater) on a periodic basis to evaluate the Pilot System; and
- supplemental evaluations (groundwater and surface water, e.g., Sullivan Creek Assessment [EIP, 1999] and Pilot System performance studies (Appendix A)).

Results of the Site monitoring indicate that the closure systems are performing well. In 1999, Lehigh conducted an ecological assessment of Sullivan Creek, without Ecology oversight. The study [EIP, 1999] concludes that surface water in the creek is of excellent chemical and biological quality. However, the groundwater downgradient of the Closed CKD Pile, which discharges to Sullivan Creek, remains affected by high levels of pH and elevated arsenic concentrations.

2.6 Feasibility Study Technical Memorandum

The FSTM screened 20[7] groundwater remedy alternatives [GeoSyntec, 2003b]. Lehigh determined that five alternatives passed the screening criteria and recommended that they be evaluated more extensively in the FSTR. After its review of the FSTM, Ecology recommended that the FSTR also include source abatement alternatives (i.e., Additional Source Control and Partial Source Removal[8]). The FS process, which included further discussions with Ecology, led to the inclusion of two more alternatives. It also led Lehigh to drop one alternative from further consideration and to consolidate three technologies into a single alternative. Accordingly, the following alternatives are evaluated in this Revised dFSTR – See Exhibit ES-3.

- Alternative #1 – Permeable Treatment Wall (PTW)
- Alternative #2 – Pump and Treat (P&T)
- Alternative #3 – Additional Source Control (ASC)
- Alternative #4 – Partial Source Removal (PSR)
- Alternative #5 – Funnel and Gate Treatment (FGT)
- Alternative #6 – Partial Additional Source Control (PASC)

This Revised dFSTR evaluates each of the six alternatives in detail in subsequent sections.

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[7] In accordance with WAC 173-340-350 (8)(b).

[8] 6/11/03 Ecology correspondence to Eric Smalstig, GeoSyntec Consultants, and follow-up Ecology correspondence with Jay Manning, Esq., Brown Reavis & Manning, PLLC.

3. REGULATORY FRAMEWORK FOR ADDITIONAL REMEDY ALTERNATIVE SELECTION

3.1 Introduction

Lehigh prepared this Revised dFSTR under MTCA. The state statutes and regulations promulgated under MTCA guide the FS process, the evaluation of remedial alternatives, and subsequent remedy selection. This section of the Revised dFSTR describes the standards, criteria, and considerations guiding remedy selection.

3.2 Remedy Selection under MTCA

3.2.1 General

The process for identifying and evaluating cleanup alternatives is described in WAC 173-340-350 and -360. The general steps involved are:

- identification of alternatives;
- initial screening of alternatives; and
- evaluation of selected alternatives.

Lehigh completed the first two steps in the FSTM, which identified remedial alternatives and screened them to eliminate those that "so clearly do not meet the minimum requirements of WAC 173-340-360 that a more detailed analysis is unnecessary" [WAC 173-340-350(8)(b); see Feasibility Study Technical Memorandum for the Lehigh CKD pile, prepared by GeoSyntec and dated 22 May 2003]. This Revised dFSTR documents the third step.

As described in the following subsections, the MTCA rules specify criteria that must be used to evaluate selected alternatives.

3.2.2 Threshold Requirements

3.2.2.1 Introduction

A cleanup alternative must meet the minimum requirements specified in WAC 173-340-360(2). The following threshold requirements are used as evaluation criteria in this Revised dFSTR:

1. protect human health and the environment;
2. comply with cleanup standards;
3. comply with applicable federal and state laws; and
4. provide for compliance monitoring.

If a remedial alternative fails to meet any one of these threshold requirements, it must be eliminated from further consideration.

3.2.2.2 Protect Human Health and the Environment

The first threshold requirement, that the remedy protect human health and the environment, is also an evaluation criterion under the 1999 AO ("overall protection of human health and the environment"). Cleanup actions that attain cleanup levels at the applicable point of compliance, and comply with applicable state and federal laws, are presumed to be protective of human health and the environment [WAC 173-340-702(5)].

3.2.2.3 Cleanup Standards

The second threshold requirement is that the remedy meets MTCA cleanup standards. When a cleanup action is selected, cleanup standards are set for specific contaminants of concern and for each affected medium, such as groundwater. "Cleanup standards" consist of three elements:

- Cleanup levels (maximum allowable concentrations of a hazardous substance in a given medium) (see WAC 173-340-700(3)(a)).

- Point of compliance where compliance with the cleanup level will be measured (see WAC 173-340-700(3)(b)).

- Other regulatory requirements that apply to the site because of the type of action and/or location of the site ("applicable state and federal laws") (see WAC 173-340-700(3)(c)).

3.2.2.4 Cleanup Levels

Cleanup levels must:

- Ensure compliance with applicable state and federal laws, also known as Applicable or Relevant and Appropriate Requirements (ARARs, see Section 3.2.2.6).

- Prevent cross-contamination of other media (WAC 173-340-700(6)(b)).

- Not be set below the practical quantification limit achievable by a chemical analytical laboratory or the natural background concentration

Cleanup levels are established by using one of three methods described in MTCA. Ecology will set final cleanup levels in the Cleanup Action Plan (CAP). For purposes of the Revised dFSTR, Lehigh assumed that Method A cleanup levels will apply[9]. Lehigh used the Method A cleanup levels set forth in tables in the MTCA regulations. The table for groundwater is Table 720-1, codified at WAC 173-340-900. The assumption of cleanup levels for this Revised dFSTR allows the six alternatives to be evaluated for their ability to meet the cleanup levels.

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[9] Method A is used to establish cleanup levels at sites that have few hazardous substances. Numerical standards must be available either in MTCA or in applicable state or federal laws for all hazardous substances in the medium for which the Method A cleanup level is used.

To select cleanup levels for contaminated groundwater, it is important to determine whether the groundwater is potable. Under MTCA, groundwater is considered potable unless:

- the groundwater does not currently serve as a source of drinking water;
- the groundwater is not a potential future source of drinking water due to inadequate supply, naturally occurring contaminants, or great depth that makes groundwater use technically impossible; and
- it is unlikely that hazardous substances will be transported to a current or potential future source of drinking water in concentrations that exceed water quality criteria in chapter 173-200 WAC (WAC 173-340-720(2)).

Groundwater at the Site is not a current source of drinking water. Lehigh plans to record a restrictive covenant that prohibits withdrawal of groundwater for domestic purposes. Groundwater at the Site discharges to Sullivan Creek. Thus groundwater cleanup levels must be set to be protective of drinking water and surface water. Method A cleanup levels shall be at least as stringent as concentrations listed under WAC 173-340-720(3). For arsenic, the most stringent of these concentrations is the National Toxics Rule (NTR) concentration of 0.018 ppb which is less than the Method A level of 5ppb. The Method A level is derived from the arsenic background concentration of 5 ppb in groundwater. Since the NTR concentration of 0.018 ppb is less than the background concentration of approximately 5 ppb, the groundwater Method A cleanup level for arsenic of 5 ppb will apply. The pH cleanup level, based on the water quality criteria under WAC 173-201A WAC, ranges from 6.5 to 8.5 standard units.

3.2.2.5 Point of Compliance

Ecology will define the POC in the CAP. MTCA provides for the selection of either a "standard" or a "conditional" POC, depending on the medium at issue and other site-specific factors.

Under a standard POC, cleanup levels must be met everywhere, throughout a site. Specifically:

- "Site" is defined to include "any ... area where a hazardous substance ... has come to be located" (WAC 173-340-200).

- For groundwater, this includes meeting cleanup levels from the uppermost level of the saturated zone extending vertically to the lowest depth that could be affected by the site (WAC 173-340-720(8)(b)).

Ecology may grant a conditional POC for groundwater where it can be demonstrated that it is not practicable to meet the cleanup level throughout the Site within a reasonable restoration time frame. This practicability analysis is governed by the factors set out in WAC 173-340-350 and 360, and is described in greater detail below in Section 3.2.3. If a conditional POC is used, it must be set "as close as practicable to the source of hazardous substances" and must not exceed the property boundary unless the off-property exception of WAC 173-340-720(8)(d) applies. In addition, "all practicable methods of treatment" must be used.

As described in Section 4, there is not a practicable remedial alternative that will meet groundwater cleanup levels throughout the Site within a reasonable restoration time frame. Consequently, Lehigh proposes a conditional POC for groundwater at a location downgradient of the Closed CKD Pile and selected treatment facilities, but upgradient of Sullivan Creek. Ecology will define the POC in the CAP. The Revised dFSTR assumed the conditional POC briefly described as a basis to evaluate the alternatives against. The discussion in Sections 4 and 5 demonstrates that this location meets the requirements of WAC 173-340-720(8)(c) because: (1) a standard POC is not practicable; (2) it is as close as practicable to the source of the hazardous substances; (3) it does not exceed the property boundary; and (4) all practicable methods of treatment will be used. Each of the alternatives evaluated in this FS process incorporates treatment-based remedies. There is inherent variability involved in operating engineered treatment systems. The method of evaluating compliance with cleanup standards will be established during development of the monitoring program defined in the CAP and design phases of the project, and ultimately approved by Ecology.

Lehigh owns the land affected by the plume, including the proposed conditional POC for groundwater, with the exception of the State Route 31 and its right-of-way. As such, the off-property conditional POC exception of WAC 173-340-720(8)(d) need not be applied.

3.2.2.6 Applicable Federal and State Laws - ARARs

The third threshold requirement is that the remedy complies with applicable federal and state laws, which "include (a) all legally applicable requirements and (b) those requirements that the department determines are "relevant and appropriate requirements." These are referred to jointly as ARARs (WAC 173-340-710(1)). The 1999 AO also requires that this factor ("compliance with remedial action objectives (RAOs) and ARARs") be used in evaluating selected alternatives. "Relevant and appropriate requirements" include those cleanup standards, standards of control, and other environmental requirements, criteria, or limitations established under state or federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at that site that their use is well suited to the particular site (WAC 173-340-710(4)). WAC 173-340-710(7) identifies a number of state and federal laws, compliance with which must be considered in the cleanup action selection process if applicable. Lehigh analyzed various ARARs, permits, and approvals that apply to the remedy alternatives described in this Revised dFSTR. Exhibit 3.2-1 summarizes Lehigh's analysis.

ARARs may include requirements to obtain permits or other regulatory approvals to conduct some part of the cleanup. Under MTCA, a person conducting a cleanup under an order or consent decree is exempt from any requirements to obtain state or local permits or approvals for the remedial action. (RCW 70.105D.090). However, Ecology must ensure compliance with the substantive provisions of any such state or local laws. This usually requires consultation with the state or local agency that administers the relevant law. Ecology will address these issues in more detail in the CAP.

MTCA has no exemption for any federal permits or approvals required to conduct the remedial action. Thus, Lehigh must obtain any required federal permits, and must meet the substantive provisions of any state or local laws that would, but for the MTCA exemption, require a permit or approval.

Lehigh has identified applicable state and local laws that, but for the MTCA exemption, might require a permit or approval to implement one or more of the six alternatives. Lehigh also has identified the federal laws that could require Lehigh to obtain permits or approvals to implement one or more alternatives. Depending on the alternative, the applicable federal, state, and local programs are, as follows:

- Federal:
  - Clean Water Act Section 404 dredge and fill permit and Rivers and Harbors Act Section 10 permit
  - Clean Water Act Section 402 NPDES permit
  - Clean Water Act Section 401 water quality certification

- State:
  - Hydraulics Project Approval
  - Aquatic Use Authorization
  - State Waste Discharge permit
  - Water Right permit

- Local:
  - Shoreline Management permit
  - Floodplain Management permit
  - Clearing/grading/building permit

In Exhibit 3.2-1, Lehigh shows the alternatives potentially subject to each of these federal, state, and local programs. Each alternative requires a combination of permits or is subject to certain restrictions. Lehigh's preliminary research shows that there are no significant restrictions or permitting programs that would make any remedy difficult to implement. Specific permit issues are usually resolved during remedy design for MTCA Clean Ups. Of all the programs identified, the NPDES permitting process requires the most amount of time to complete, approximately six to nine months. Thus, the remainder of the Revised dFSTR emphasizes the NPDES process due to its effect on the project schedule.

3.2.2.7 Compliance Monitoring

The final threshold requirement is that any remedy implemented under MTCA must provide for "compliance monitoring." The 1999 AO also requires that this factor ("provision for compliance monitoring") be used in evaluating selected alternatives. Compliance monitoring consists of three different types of monitoring:

- Protection Monitoring: performed during remedy construction for protection of workers, the public, and the environment;

- Performance Monitoring: confirms that the remedy has met cleanup standards;

- Confirmation Monitoring: affirms that the remedy will be effective in the long term in meeting cleanup standards.

3.2.3 Other Requirements

3.2.3.1 Introduction

WAC 173-340-360(2)(b) defines conditions, referred to as "Other Requirements," that any remedy must meet in addition to the threshold requirements. They are:

1) use permanent solutions to the maximum extent practicable;

2) provide for a "reasonable restoration timeframe" to meet cleanup levels; and

3) consider public concerns.

3.2.3.2 Permanent Solutions to the Maximum Extent Practicable

3.2.3.2.1 General

MTCA does not require that a permanent cleanup action alternative be selected. Rather, Ecology must select a remedy that "uses permanent solutions to the maximum extent practicable." It must use the "disproportionate cost analysis" to determine whether a cleanup action alternative meets this requirement (WAC 173-340-360(3)(b)).

One of the criteria in the disproportionate cost analysis is permanence (WAC 173-340-360(3)(f)(ii)). This criterion is closely related to the concept of "permanent solution," but because differences between the two terms are important they are discussed separately in the Revised dFSTR.

3.2.3.2.2 Permanent Cleanup Action

"Permanent solution" or "permanent clean-up action" means a cleanup action that meets the cleanup standards of WAC 173-340-700 – 173-340-760 without further action being required at a site being cleaned up or at any other site involved with the cleanup action, other than the approved disposal of any residue from the treatment of hazardous substances (WAC 173-340-200 (definition of "permanent solution" or "permanent cleanup action")).

MTCA generally requires that the FS include at least one permanent cleanup action alternative to serve as a baseline against which other alternatives are evaluated to determine which is "permanent to the maximum extent practicable" (WAC 173-340-350(8)(c)(ii)). However, the FS need not include a permanent cleanup action alternative if none is "technically possible" (WAC 173-340-350(8)(c)(ii)(B)(II)). MTCA defines "technically possible" as "capable of being designed, constructed and implemented in a reliable and effective manner, regardless of cost" (WAC 173-340-200).

Ecology and Lehigh understand the term "permanent" differently, as explained below. However, this difference of opinion does not affect the evaluation of alternatives in this Revised dFSTR.

Lehigh believes that no "permanent" remedies exist for the Site because no treatment process has been identified that can completely render the CKD inert. As Lehigh understands MTCA, the only remedies that meet the definition of permanent are those that treat the hazardous substances, rendering them non-hazardous. Treatment may occur on-site or off-site, but the remedy will not qualify as permanent if any further remedial action (including monitoring, institutional controls, or maintenance) is required (see WAC 173-340-200).

For example, Lehigh does not believe that source removal and off-site disposal is a permanent remedy since further remedial action would be required to manage the removed hazardous substances at the disposal facility. Any CKD removed from the pile would have to be transported to a permitted disposal facility, which would in turn require engineering controls, monitoring, and possibly remediation. This is "further action." Thus, in Lehigh's view removal and off-site disposal cannot be a permanent solution.

Source removal or source isolation alternatives also would have to be supplemented with on-site groundwater remediation, another form of "further action." Lehigh believes that the only way to eliminate the need for downgradient groundwater treatment is to remove the entire Closed CKD Pile and to render it completely inert. Unless all of the CKD is excavated and moved elsewhere, Lehigh believes that it is not technically possible to reduce contact between groundwater and the Closed CKD Pile sufficiently to result in groundwater meeting cleanup levels. Even after full pile removal, it will take many years for natural attenuation to cleanse the groundwater and subsurface materials, so that groundwater meets clean up levels throughout the Site. Lehigh has presented data and analysis that support this belief [GeoSyntec, 2004]. These analyses show that more than 99% of the contact must be eliminated before cleanup levels would be met. Since this level is not achievable, supplemental groundwater remediation would be required for an indefinite time period to meet cleanup levels. Such groundwater remediation is "further action," which means that neither source removal nor source control is a permanent remedy.

Furthermore, even if groundwater ceased to contact the Closed CKD Pile, through some form of source control, MTCA would require engineering controls and long-term monitoring to maintain the long-term effectiveness of the source control alternative (WAC 173-340-360(3)(f)(iv) and 173-340-410(3)). Thus, because all of the partial source removal or source control options would require "further action" either at the Site or at an off-site disposal facility, Lehigh believes that none of them qualifies as a permanent remedy.

Ecology has indicated that it believes that PSR with off-site disposal and remediation of residual CKD-affected groundwater is a permanent remedy, even if the removed hazardous substances are not treated or destroyed. Based on conversations with Ecology, they believe that PSR is permanent remedy for the following reasons: the majority of CKD-water contact occurs where the base is inundated, and removing that base area will sufficiently reduce overall CKD-water contact; PSR could be designed and implemented with a high degree of reliability; the remaining CKD-water contact could be diluted by unaffected groundwater so that groundwater beneath the Closed CKD Pile meets cleanup levels; and greater than 99% effectiveness is not required for PSR to be permanent.

Although Ecology and Lehigh disagree whether there are any permanent cleanup action alternatives for this Site, they agree that PSR offers the greatest degree of "permanence," a concept described below in Section 3.2.3.2.4. MTCA requires that, if a permanent cleanup action alternative is not available, the alternative with the greatest degree of permanence shall be the baseline cleanup action alternative (WAC 173-340-360(3)(e)(ii)(B)). PSR therefore will be the baseline against which other alternatives are evaluated.

3.2.3.2.3 Disproportionate Cost Analysis

Under the disproportionate cost analysis, "costs are disproportionate to the benefits provided by a remedy if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative" (WAC 173-340-360(3)(e)(i)).

The disproportionate cost analysis takes into consideration the following seven factors, which are adopted as evaluation criteria in this Revised dFSTR:

- protectiveness;

- permanence;
- cost;
- effectiveness over the long term;
- management of short-term risks;
- technical and administrative implementability; and
- public concerns.

The 1999 AO also requires that these factors (described in the Agreed Order as "overall protection of human health and the environment"; "permanent reduction of mobility, toxicity, and volume"; cost; "long-term effectiveness"; "short-term effectiveness"; "implementability"; and "community concerns") be used in evaluating selected alternatives.

3.2.3.2.4 Permanence

As stated above, the second of these criteria, "permanence" is related, but not identical, to the concept of a "permanent" remedy. MTCA defines "permanence" as follows:

> *(ii) Permanence. The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.*

A cleanup action that requires further action to meet cleanup standards is not permanent, but it may still exhibit a high degree of permanence. For example, although Lehigh does not believe that PSR is permanent, Ecology and Lehigh agree that PSR has a high degree of permanence because it reduces the toxicity, mobility, and volume of hazardous substance releases. Because cleanup treatment components reduce the toxicity and mobility of hazardous substance releases, the treatment exhibits permanence.

The regulations require that the degree of permanence, even of non-permanent remedies, be considered during remedy selection. The Revised dFSTR evaluates the alternatives with respect to this characteristic, as well as the other criteria in the disproportionate costs analysis.

3.2.3.2.5 Cost

The Revised dFSTR presents costs for the alternatives in 2005 U.S. dollars. Lehigh developed three scenarios for the cost calculations. First, the standard thirty-year project duration with a seven percent discount rate is presented. Lehigh included a second scenario using a one hundred-year project duration because of the indefinite time period that most alternatives will need to operate. The second scenario uses a seven percent discount rate and a one hundred year period. Lehigh developed a third scenario based on Ecology comments and EPA guidance [EPA, 2000a]. EPA guidance suggests that a non-discounting scenario be presented only for comparison purposes. The third scenario uses the one hundred-year project duration. The cost estimates also included periodic replacement or rehabilitation costs for minor and major alternative components.

3.2.3.2.6 Restoration Time Frame

The reasonableness of a proposed restoration time frame—the period of time required to achieve cleanup levels at the POC—is determined by considering a number of factors, including those in WAC 173-340-360(4)(b):

- potential risks to human health and the environment;
- practicability of a shorter time frame;
- current use of the site, surrounding areas, and associated resources that may be affected by releases at the site;
- potential future use of the site, surrounding areas, and associated resources;

- availability of alternative water supplies;
- likely effectiveness and reliability of institutional controls;
- ability to control and monitor migration of hazardous substances from the site;
- toxicity of those substances; and
- natural processes that reduce concentrations of hazardous substances.

The 1999 AO also requires that this factor ("restoration time frame") be used in evaluating selected alternatives.

3.2.3.2.7 Public Concerns

Public concerns must be considered following the public participation process set out in WAC 173-340-600.

3.2.3.2.8 Agreed Order Criterion

The 1999 AO establishes the following additional criterion that is also used in this Revised dFSTR to evaluate alternatives: Prevent Domestic Uses of CKD-Affected Groundwater.

3.2.4 Groundwater Cleanup Requirements

The MTCA regulations contain specific requirements for cleanups that address contaminated groundwater in WAC 173-340-360(2)(c)(i):

> *Permanent ground water cleanup actions. A permanent cleanup action shall be used to achieve the cleanup levels for ground water in*

WAC 173-340-720 at the standard point(s) of compliance (see WAC 173-340-720(8)) where a permanent cleanup action is practicable or determined by the department to be in the public interest.

As discussed above, Lehigh and Ecology disagree whether there is a permanent remedy for this Site. Even if PSR is a permanent remedy, it is not practicable because its costs are disproportionate to its benefits, as discussed below in Chapter 5.[10]

MTCA recognizes that permanent cleanup actions are not available or not practicable at all sites. When a permanent cleanup action is not selected for groundwater, Ecology must ensure that:

- highly mobile hazardous substances, liquid wastes, highly concentrated hazardous substances, or those that cannot be reliably contained are removed or treated (WAC 173-340-360(2)(c)(ii)(A)); and

- groundwater containment measures are implemented to avoid lateral and vertical expansion of the groundwater volume affected by the hazardous substance (WAC 173-340-360(2)(c)(ii)(B)).

As discussed below in Section 4, the six alternatives evaluated for the Site involve treatment components, which satisfies WAC 173-340-360(2)(c)(ii)(A). The Closed CKD Pile cover is a containment measure, and each of the six alternatives uses techniques to control the spreading of the CKD-affected groundwater plume. Thus, each of the six alternatives meets the nonpermanent groundwater cleanup requirements of WAC 173-340-360(2)(c)(ii).

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[10] In 1994, Ecology concluded that full CKD Pile removal was not a viable option. The following quote contains Ecology's conclusion [Ecology, 1994]:

> "Ecology believes that excavation and/or treatment of the CKD waste pile to meet MTCA cleanup levels is not economically feasible. It is our opinion that the CKD waste pile should be closed in place..."

Section 4 presents the analysis of six groundwater remedy alternatives with respect to the aforementioned criteria. Section 5 contains the comparative analysis of the six alternatives.